

Properties and Classifications of Matter

PS-3 The student will demonstrate an understanding of various properties and classifications of matter.

PS-3.8 Classify various solutions as acids or bases according to their physical properties, chemical properties (including neutralization and reaction with metals), generalized formulas, and pH (using pH meters, pH paper, and litmus paper).

Taxonomy Level: 2.3-B Understand Conceptual Knowledge

Key Concepts:

Acid: acidic solution

Base: basic solution

pH scale

Neutral solution, Neutralization reaction

Previous/Future knowledge: In 7th grade (7-5.6) students distinguish between acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH. In chemistry (C-6) students will further develop the concepts of acids and bases by determining strong and weak acids and bases, as well as, using hydronium and hydroxide ion concentrations to determine pH and pOH of solutions.

It is essential for students to

- Understand that one of the important working definitions of an *acid* is a chemical that releases hydrogen ions (H^+) in solution and that a *base* is a chemical which releases hydroxide ions (OH^-) in solution.
- Understand that the *pH scale* is a way to measure the concentration of hydrogen ions in solution. It measures how acidic or how basic a solution is.
 - The pH of a solution can be measured using pH paper, litmus paper, or pH meters.
 - The pH range of many solutions falls between 0 and 14.
 - The pH of pure water is 7. Any solution with a pH of 7 contains equal concentrations of H^+ and OH^- and is considered a *neutral solution*. It is not an acidic or a basic solution.
 - The pH of an acidic solution is less than 7. It contains more H^+ than OH^- . A lower number indicates more hydrogen ions. The lower the number the more acidic the solution.
 - The pH of a basic solution is greater than 7. It contains less H^+ than OH^- . A higher number indicates more OH^- ions. The higher the number the more basic the solution is.
- Understand the physical and chemical properties of *acidic solutions*.
 - Acidic solutions conduct electricity (are electrolytes).
 - Acidic solutions have a tart or sour taste (Caution! Students should never taste anything in science lab).
 - Acidic solutions turn blue litmus paper red; other indicators will turn a specific color for each pH value.
 - Acidic solutions have a pH less than 7.
 - Acids react with active metals such as zinc and magnesium.
 - For the purposes of Physical Science, the formula of an acid can be recognized because the first element in the formula is hydrogen. (Since water does not give up an H^+ readily, it will not be classified as an acid in this course.)
 - Examples might include:
 - HCl Hydrochloric acid (stomach acid)
 - H_2SO_4 Sulfuric Acid (common industrial acid)

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- Understand the physical and chemical properties of *basic solutions*.
 - Basic solutions have a slippery feel
 - Basic solutions conduct electricity (are electrolytes)
 - Basic solutions have a pH greater than 7
 - Red litmus paper turns blue in the presence of a basic solution; other indicators will turn a specific color for each pH value
 - For the purposes of Physical Science, the formula of a base can be recognized because the formula ends in OH.
 - Examples might include.
 - NaOH Sodium Hydroxide (drain cleaner)
 - $\text{Ca}(\text{OH})_2$ Calcium Hydroxide (hydrated lime - fertilizer)
- Understand the process of *neutralization*:
 - Acids and bases react to form water and a salt. This type of reaction is often called a *neutralization reaction* because the hydrogen ions from the acid and hydroxide ions from the base react to form water molecules (water is neutral).
 - An acid is used to neutralize a base; a base is used to neutralize an acid.
- Understand and be proficient at carrying out laboratory procedures for determining the pH of an unknown solution using pH paper or a pH meter, as well as, for determining whether an unknown substance is an acid or a base using litmus paper.

It is not essential for students to

- Understand the different theories of acids and bases (Arrhenius, Bronsted-Lowry, or Lewis);
- Understand or be familiar with the nomenclature for acids;
- Understand or be familiar with pH or pOH calculations;
- Remember the specific pH of common acids or bases;
- Differentiate between strong/weak acids and concentrated/dilute acids.

Assessment Guidelines:

The objective of this indicator is to classify various substances as acids or bases and various solutions as acidic or basic according to properties, formulas, and pH, therefore, the primary focus of assessment should be to categorize a substance based on the criteria in the indicator.

In addition to *classify*, assessments may require that students

- Exemplify acidic or basic solutions based on their properties;
- Identify an acid or a base using its formula;
- Compare acids to bases with reference to relevant characteristics which define each category;
- Summarize the major points which define each category; or
- Infer from data the correct classification (acidic or basic) of an unknown solution.